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COMBAT RATION NETWORK FOR TECHNOLOGY IMPLEMENTATION

Polymeric Tray Manufacturability, Part I

Final Technical Report STP1002A
Results and Accomplishments (January 1998)
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13. ABSTRACT *(Maximum 200 words)*

The polymeric tray replacement for the metal tray-can is an urgent program of great importance to the Military Services, especially since the metal cans are again showing evidence of premature deterioration. The U.S. Army Natick Research, Development & Engineering Center has identified a polymeric container as replacement to the metal tray-can.

On January 19-23, 1998, a production test was conducted at Star Foods Processing Inc, San Antonio, TX to quantify the manufacturability of selected products under documented production conditions. An assessment was made to the suitability of the prevailing military performance specifications versus the capability of the process.

This document reports on the findings from that study and identified areas where the process was capable of producing within specification limits as well as areas where the process lacked this capability. Product from this production test were sent to the U.S. Army Natick Research, Development & Engineering Center for further testing and evaluation of package integrity. The results of that study are not included in this report.

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Summary

The CORANET Manufacturability Study conducted January 19 – 23, 1998 at Star Foods, San Antonio Texas had two objectives: 1) Determine whether the selected Polymer Tray items can be economically and satisfactorily manufactured under normal production conditions and in accordance with the Military Specifications, and 2) Quantify the Manufacturability of selected Polymer Tray products under documented production conditions. Production at Star Foods included process setups for the purpose of pre-production tests but did not include those significant equipment investments that could be justified by an on-going business in the products.

The specification maximum Residual Gas of 175 cc was not met with the average container having 325 cc. This characteristic defined the critical process capability index and resulted in negative values as compared to a Process Capability Index (PCI) target of +1.2 or better. Of 26 PCIs computed, only 8 were better than 1.2 and 6 of those were for characteristics such as salt and fat content. Seals and internal pressure (measures of seal area contamination and seal strength) averaged +0.72 and +0.45 respectively (below the target of +1.2). Net weight (filling process) PCI , depending on product, ranged from +0.68 to +1.61.

Yields of the four products (a traditional measure of process performance), ranged from 93.9% to 97.3% at the Filling/Sealing Inspection location (losses of between 2.7% and 6.1%). Additional losses occurred during pre-retort inspection (3.7% to 2.3%) and again post retort (0.3% to 6.5%).

The overall production rates for the products ranged from 2.0 trays/minute to 3.7 trays/min. These rates represent a state early in the product manufacture learning curve as well as associated with equipment at hand rather than equipment (capital investment) specific to the product production on an ongoing basis.

Test Variables

A total of four products were produced at Star Foods during the week of January 19, 1977. The four products were:

- White Rice NSN: 8920-01-445-5736
- Chicken Chow Mein NSN:8940-01-446-0214
- Chicken Breast NSN:8940-01-445-5737
- Ham Slice in Brine NSN: ????-??-???-????

Of each product approximately 2000 containers were produced in various type trays. The Type II tray is the same as the type I tray, with the exception of an additional oxygen barrier. Each tray was also tested in two weight version: 155 gram and 125 gram
Therefore, the following tray configurations were tested:

- Type I/155 tray
- Type II/155 tray
- Type I/125 tray (only used for Chicken Chow Mein and Ham Slice)
- Type II/125 tray (only used for Chicken Chow Mein and Ham Slice)

Results

During the production observations were made by the CORANET Manufacturability Study Team. The results can be divided into three catagories:

1. General Comments and Observations around the Filling and Sealing Line
2. Traditional Process Performance Measurements such as Yield and Line Efficiencies
3. Process Capability Measurements to produce product within specification limits

General Comments and Observations

Rexam Tray:

Trays were observed for possible distortion that could lead to handling or sealing problems. Observations were made of filled trays entering the seal chamber for the following categories; sidewall bulge, corner distortion, flange distortion and bottom distortion. Results of these observations are no tray defects or occurrences of tray distortion were reported for any of the four tray configurations. One tray was torn down and thickness measured:

	Measured	Rexam Specification
Flange thickness	.050"-.075"	max. range .020"
Corner thickness	.028" min.	.020" min.

Heat Sealer:

- Lidstock Advance. The lidstock advance mechanism required constant operator attention and was the primary cause of cycle aborts and partially sealed trays. The lidstock was set to over-advance approximately 8", thereby using approximately 50% more film.
- Seal Width. Narrow seals were noted on the final day of production at corners toward the discharge end of the sealer. This problem was due to slight misalignment of the seal plate and tray. Possible causes are; heat sealer carrier does not match flange dimensions, tray dimensions vary or shrink, or sealer tooling has shifted.
- Vacuum System. There was one occurrence of vacuum system malfunction, when frozen water obstructed the operation of the vacuum regulator valve. Vacuum pressure was partially lost for a period of time, possibly 0.5 hours before the problem was detected by routine QC test. During this condition trays were produced with substantially higher residual gas levels. A pressure sensor should be added to the sealer electronic control system.
- Residual gas. The process could not demonstrate any capability to produce a product within the specification limits for "Residual Gas". Residual Gas level is determined by various factors such as the vacuum applied during the sealing process, the headspace in the container between product and lid and the temperature of the headspace. Increasing the vacuum level during sealing might reduce the residual gas level but could reduce the seal quality.

Traditional Process Performance Measurements

Production Efficiency:

The production line speed can be reported as three numbers. The first number is the actual line speed set-point of the sealer. The second number is the average line speed of the filling and sealing operation, not counting major breakdowns. The third number is the average production rate over the entire day, counting breaks for major equipment breakdowns, adjustment of equipment, personnel breaks, etc. All data is reported in Trays/Min

	Sealer Speed	Filling/Sealing	Production Rate
White Rice	7.0	4.4	3.4
Chicken Chow Mein	7.0	4.0	3.7
Chicken Breast	6.2	4.9	2.0
Ham Slice in Brine	6.1	4.5	3.4

Production Yield:

At several locations the product and container were inspected. The first inspection location was during the filling and sealing operation where the operators remove any trays with gross defects: "Filling and Sealing Inspection". Next all trays were inspected before they were loaded onto retort crates: "Pre-Retort Inspection". The last point of inspection was after the retort process but before product casing: "Post Retort Inspection". If a container is found to be potentially defective then the container was removed from the production line. Product in containers removed before the retort process was typically recycled, and only resulted in the economic loss of the container. Containers removed from the production line after the retort process were either destroyed, used for commercial sale or used for Quality Control testing. The table below reports on the yield [%] at the various inspection points.

	Trays Retorted	Yield Fill/Sealing	Yield Pre-Retort	Yield Post Retort
White Rice	2154	93.9	97.7	93.5
Chicken Chow Mein	2056	94.4	97.4	98.8
Chicken Breast	2058	TBD	96.3	97.3
Ham Slice in Brine	2058	97.3	97.4	99.7

Process Capability Analysis

Process Capability is the capability to produce product within the specification limits. The analysis were limited to the product and tray characteristics, such as net weight, drain weight, fat and salt content, residual gas and internal pressure. Capability analysis was done separately on data from each individual data source: STAR Foods, USDA and CORANET. The capability index for meeting the "Internal Pressure Test" is reported at the end of the section and pertains to the overall capability during the week. The process capability index (PCI) reported is a direct indication to the capability of the process to produce product within specification limits. The target PCI is "1.2" or better. A PCI=1 means that the process produces 99.7% of the product within specification limits. A PCI=0 means that 50% of the product is defective. A PCI<0 means that the majority of the product is defective. Additional information on the interpretation and calculation of PCI can be obtained by requesting TWP#106: "A producibility index with process capability and manufacturing cost"

Within the limited data set, no differences were observed between the various tray configurations. The data was therefore grouped together per product and analyzed as such.

To assess the producibilty in regards to "Internal Pressure", an estimation of the defect rate in the product needed to be made. This required a significant amount of samples to be tested and could only be determined by grouping all product samples together and estimating the number of non-conforming units over the total production run.

Process Capability Summary

	White Rice	Chicken Chow Mein	Chicken Breast	Ham Slice
Net Weight [1]	1.61	0.84	1.12	0.68
Drain Weight [2]		1.25	0.05	0.35
Whole Meat Weight [2]		0.77		
Salt	2.14	1.88	Infinite	1.1
Fat		5.94		3.6
Residual Gas [2]	-0.78	-1.18	-2.53	-1.05
Internal Pressure [3]	0.45	0.45	0.45	0.45
Seals [4]	0.72	0.77	0.61	0.79
PCI Critical	-0.78	-1.18	-2.53	-1.05
PCI Average [5]	0.80	0.66	0.67	0.62
MC [6]	4.4	4.0	4.9	4.5

1) PCI index for net weight is based on a geometric means between CORANET, USDA and STAR collected data.
2) PCI index for drain weight, whole meat weight and residual gas are based on USDA collected data set as it was performed a week after production at which time the food system was more equilibrated
3) PCI index for internal pressure is based on combined USDA and STAR data set
4) PCI index for seal defects is based on pre retort and post retort screening operation
5) PCI Average based on the geometric means of the PCI for net weight, internal pressure and seal defects
6) MC index (Manufacturing Cost) is based on the average filling and sealing line speed

PCI Analysis White Rice

Net weight
Specification Limits: Average 88 oz net weight on a 30 trays sample and no individual less than 86 oz net weight. Weights shall be reported to the nearest 1-ounce, hence the spec limit for process capability analysis is 87.5 and 85.5 oz.

STAR data set: avg. = 87.7 oz and sigma=0.60 oz, hence the minimum PCI is 0.612 as determined by the average spec limit (87.5 oz).

USDA data set: avg. = 88.13 oz and a sigma = 0.57, hence the minimum PCI is 1.53 as determined by the individual spec limit (85.5 oz)

CORANET data set: avg. = 88.2 oz and a sigma = 0.2, hence the minimum PCI is 4.5 as determined by the average spec limit (87.5 oz)

Residual Gas
Specification Limits: Residual gas maximum 175 cc. Actual volume should be reported to the nearest 1 cc, hence the spec limit for process capability analysis is 175.4 cc.

STAR data set: Average = 318 cc and sigma=19.8, hence the PCI = -2.40

USDA data set: Average = 290 cc and sigma 49.5, hence the PCI = -0.78

Salt
Specification Limits: Salt between 0.5 and 1.5%. Test results should be reported to the nearest 0.01%, hence the spec limit for process capability analysis is 0.495 and 1.504

STAR data set: Average = 1.13% and sigma = 0.06%, hence PCI = 2.14

USDA data set: No data available

PCI Analysis Chicken Chow Mein

Net weight
Specification Limits: Average 92 oz net weight on a 30 trays sample and no individual less than 90 oz net weight. Weights shall be reported to the nearest 1-ounce, hence the spec limit for process capability analysis is 91.5 and 89.5 oz.

STAR data set: avg. = 91.74 oz and sigma = 0.54 oz, hence the minimum PCI is 0.80 as determined by the average spec limit (91.5 oz).

USDA data set: avg. = 93.2 oz and a sigma = 1.37, hence the minimum PCI is 0.90 as determined by the individual spec limit (89.5 oz)

CORANET data set; avg. = 93.25 oz and sigma = 1.52 oz, hence the minimum PCI is 0.82 as determined by the individual spec limit (89.5 oz)

Drain weight
Specification Limits: Average 48.0 oz net weight on a 8 trays (N=2000,S3/Aql=4.0, double sampling plan) sample and no individual less than 46.0 oz net weight. Weights shall be reported to the nearest 0.1-ounce, hence the spec limit for process capability analysis is 47.95 and 45.95 oz.

STAR data set: avg. = 54.55 oz and sigma = 3.42 oz, hence the minimum PCI is 0.84 as determined by the individual spec limit (45.95 oz).

USDA data set: avg. = 58.01oz and a sigma = 3.22 oz, hence the minimum PCI is 1.25 as determined by the individual spec limit (45.95 oz)

Chicken Weight
Specification Limits: On a 8 trays (N=2000,S3/Aql=4.0, double sampling plan) sample no individual less than 10.0 oz net weight. Weights shall be reported to the nearest 0.1-ounce, hence the spec limit for process capability analysis is 9.95 oz.

STAR data set: avg. = 10.41oz and sigma = 0.31oz, hence the minimum PCI is 0.49 as determined by the individual spec limit (9.95 oz).

USDA data set: avg. = 10.16 oz and a sigma = 0.09 oz, hence the minimum PCI is 0.77 as determined by the individual spec limit (9.95 oz)

Residual Gas
Specification Limits: Residual gas maximum 175 cc. Residual gas levels shall be reported to the nearest 1 cc, hence the spec limit for process capability analysis is 175.5 cc.

STAR data set: Average=391 cc and sigma=28.3, hence the PCI= -2.55

USDA data set: Average=337 cc and sigma 45.5, hence the PCI = -1.18

Salt
Specification Limits: Salt between 0.5 and 1.3%. Results shall be reported to the nearest 0.1%, hence the spec limit for process capability analysis is 0.495 and 1.35 oz.

STAR data set: Average = 0.95% and sigma=0.07%, hence PCI = 1.88

USDA data set: No data available

Fat
Specification Limits: Fat not more than 7%. Results shall be reported to the nearest 0.1%, hence the spec limit for process capability analysis is 7.05%

STAR data set: Average = 2.93% and sigma=0.23%, hence PCI = 5.94

USDA data set: No data available

PCI Analysis Chicken Breast Meat in Gravy

Net weight
Specification Limits: Average 95 oz net weight on a 30 trays sample and no individual less than 93 oz net weight. Results shall be reported to the nearest 1-ounce, hence the spec limit for process capability analysis is 94.5 and 92.5 oz.

STAR data set: avg=95.9 oz and sigma=1.12 oz, hence the minimum PCI is 1.01 as determined by the individual limit (92.5 oz).

USDA data set: avg=96.3 oz and a sigma=1.32 oz, hence the minimum PCI is 0.96 as determined by the individual spec limit (92.5 oz)

CORANET data set; avg=96.4 oz and sigma=0.9 oz, hence the minimum PCI is 1.44 as determined by the individual spec limit (92.5 oz)

Drain weight
Specification Limits: Average 42 oz net weight on a 8 trays (N=2000,S3/Aql=4.0, double sampling plan) sample and no individual less than 40 oz net weight. Results shall be reported to the nearest 0.1ounce, hence the spec limit for process capability analysis is 41.95 and 39.95 oz.

STAR data set: avg=43.5 oz and sigma=1.20 oz, hence the minimum PCI is 0.97 as determined by the individual spec limit (39.95 oz).

USDA data set: avg=42.1 oz and a sigma=3.16 oz, hence the minimum PCI is 0.05 as determined by the average spec limit (41.95 oz)

CORANET collected data during the filling process and recorded the following statistical data: avg=72.8 oz, sigma=1.8 oz, max=78.0 oz, min=68.8 oz

Residual Gas
Specification Limits: Residual gas maximum 175 cc. Results shall be reported to the nearest 1 cc, hence the spec limit for process capability analysis is 1755 cc.

STAR data set: Average=341 cc and sigma=31, hence the PCI= -1.73

USDA data set: Average=326 cc and sigma 19.8, hence the PCI = -2.53

Sauce Viscosity
Specification Limits: Minimum: 7.5 cm, Maximum: 16 cm. Results shall be reported to the nearest 0.1 cm, hence the spec limit for process capability analysis is 7.45 and 16.05 oz.

STAR data set: Average=13.09 cm and sigma=1.61, hence the PCI= 0.61 based on the upper specification limit (16.05 cm)

USDA data set: Average=13.99 sec and sigma=4.40, hence the PCI= 0.16 based on the upper specification limit (16.05 seconds)

Salt
Specification Limits: Salt between 0.5 and 1.3%. Results shall be reported to the nearest 0.1%, hence the spec limit for process capability analysis is 0.45 and 1.35%.

STAR data set: Average = 0.6 % and sigma = 0 %, hence PCI = infinite

USDA data set: No data available

Fat
Specification Limits: Fat not more than 7.0% on the average and not more than 9.0% on each individual sample. Results shall be reported to the nearest 0.1%, hence the spec limit for process capability analysis is 6.95% and 9.05%

STAR data set: No data available

USDA data set: No data available

PCI Analysis Ham Slice in Brine

Net weight
Specification Limits: Average 92 oz net weight on a 30 trays sample and no individual less than 90 oz net weight. Weights shall be reported to the nearest 1-ounce, hence the spec limit for process capability analysis is 91.5 and 89.5 oz.

STAR data set: avg=94.55 oz and sigma=2.40 oz. hence the minimum PCI is 0.70 as determined by the individual spec limit (89.5 oz).

USDA data set: avg=94.23 oz and a sigma=2.45 oz, hence the minimum PCI is 0.65 as determined by the individual spec limit (89.5 oz)

CORANET data set; avg=94.5 oz and sigma=2.4 oz, hence the minimum PCI is 0.69 as determined by the individual spec limit (89.5 oz)

Drain weight
Specification Limits: Average 52.0 oz net weight on a 8 trays (N=2000,S3/Aql=4.0, double sampling plan) sample and no individual less than 50.0 oz net weight. Weights shall be reported to the nearest 0.1-ounce, hence the spec limit for process capability analysis is 51.95 and 49.95 oz.

STAR data set: avg=56.15 oz and sigma=3.69 oz, hence the minimum PCI is 0.56 as determined by the individual spec limit (49.95 oz).

USDA data set: avg= 55.66 oz and a sigma= 5.41 oz, hence the minimum PCI is 0.35 as determined by the individual spec limit (50 oz)

CORANET collected data during the filling process and recorded the following statistical data: avg=65.4 oz, sigma=2.2 oz, max=71.0 oz, min=61.3 oz

Residual Gas
Specification Limits: Residual gas maximum 175 cc. Results shall be reported to the nearest 1 cc, hence the spec limit for process capability analysis is 175.5 cc.

STAR data set: Average=335 cc and sigma=12.8, hence the PCI= -4.17

USDA data set: Average=337 cc and sigma 51.0, hence the PCI = -1.05

Salt
Specification Limits: Salt between 1.5 and 2.5%. Test results should be reported to the nearest 0.1%, hence the spec limit for process capability analysis is 1.45 and 2.55

STAR data set: Average = 1.6 % and sigma=0.06 %, hence PCI = 1.1 based on the lower specification limit

USDA data set: No data available

Fat

Specification Limits: Average Fat of three cans not more than 6.0% and each can not more than 8.0%. Test results should be reported to the nearest 0.1%, hence the spec limit for process capability analysis is 6.05 and 8.05

STAR data set: Average = 4.4 % and sigma=0.26 %, hence PCI = 3.6 on average fat content

USDA data set: No data available

PCI for Internal Pressure

Defect Type: Internal Pressure Test. The seal either fails or passes during this test. Number of Samples Tested: 55. Number of Failure: 5 (combined STAR and USDA results). Hence the Estimated Yield is 90.9% and the z value is 1.34 (from lookup table)

Therefore the PCI=1.34/3=0.45

PCI for Seal Defects (Entrapped Matter and Open Seals)

White Rice

Combined pre- and post retort inspection, there were 33 incidents of entrapped matter and 1 open seal for a total of 34 defects from a population of 2,154 trays retorted. The percentage defects of 1.578%, and its corresponding Z score of 2.15, leads to a PCI of 0.72.

The production filling of White Rice resulted in most of the tray lip being smeared with product and therefore no tray lip contamination data was collected during the runs. The maximum score, which could have been assigned, is 125. This score, in the case of limited data on "macaroni & cheese" at the FMT Facility, would predict 111 defective seals whereas 34 such defects were reported above.

Chicken Chow Mein

Combined pre- and post retort inspection, there were 22 incidents of entrapped matter from a population of 2,058 trays retorted. The percentage defects of 1.069%, and its Z score of 2.30, leads to a PCI of 0.77.

The combined score for tray lip contamination (individual scores averaged 1.5, 61 trays; 2.7, 123 trays; 0.2, 59 trays and 0.0, 39 trays) was 1.52. This level of contamination if followed by a lip wiping step would not have led to seal failures based on "macaroni & cheese" predictions (defects per 1000 units = 0.4147*score – 0.92).

Chicken Breast

Combined pre- and post retort, there were 34 incidents of entrapped matter and 37 open seals for a total of 71 defects from a population of 2,058 tray retorted. The percentage defects of 3.450%, and its Z score of 1.82, leads to a PCI of 0.61.

The combined score for tray lip contamination (individual scores averaged 83.6, 58 trays and 42.6; 27 trays) was 70.6. This level of contamination if followed by a lip-wiping step is predicted to generate 58 defects based on "macaroni & cheese" experience.

Ham Slice in Brine

Combined pre- and post retort, there were 15 incidents of entrapped matter and 3 open seals for a total of 18 defects from a population of 2,058 trays retorted. The percentage defects of 0.875%, and its z score of 2.38, leads to a PCI of 0.79.

No tray lip contamination data was collected. Brine addition (manually poured from measuring cup) was such that contamination was not observed. Sloshing, however, was observed as trays moved into the lid heat sealer.

General Comments Slosh and Mounding:

Slosh and mounding were observed at the heat sealer infeed. Slosh is product contamination of the tray seal area due abrupt movement of the tray by the sealer. Mounded classification refers to product filled well above tray flange and high probability of entrapping food in the seal. Seals contaminated prior to the sealer are not included in this data. This data does not reflect the efficiency of wiping/cleaning seals prior to sealing.

	Slosh	Mounding
Rice	0.0%	0.1%
Chicken Chow Mein	0.1%	0.4%
Chicken Breast	6.3%	0.9%
Ham Slice in Brine	13.8%	2.3%

Read and Write

SCIENTIFIC AND TECHNICAL INFORMATION SYSTEM

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1308	Manufacturing and Industrial Engineering and Control of Production Systems

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Code	Description
5.1	Logistics

26.2 Function Code

Code	Description
7.2	Manufacturing Technology

26.3 Technology Code

Code	Description
4.4.2	4.4.2 Computer-Aided Manufacturing, Inspection and Testing Technology

27. Resp. Org. Source	27.1 Responsible Organization Name
432549	DEFENSE LOGISTICS AGENCY FORT BELVOIR VA

27.2 Responsible Organization Component Name
J339, TECHNICAL ENTERPRISE DIVISION

27.4 Responsible Individual

Last Name	First Name	MI
EGGERS	**RUSSELL**	**K**

27.5 Resp. Indiv. Off. Sys.	27.6 Resp. Indiv. Phone	27.7 Resp. Indiv. DSN No.
J339	**703-767-1417**	**427-1417**

28. Perf. Org. Source	28.1 Performing Organization Name
410970	**RUTGERS - THE STATE UNIV PISCATAWAY NJ**

28.2 Performing Organization Component Name
CENTER FOR ADVANCED FOOD TECHNOLOGY

28.4 Performing Individual

Last Name	First Name	MI
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CORANET	**732-445-6130**	

28.8 Associate Investigator Names (Last, First, MI) JEFFREY. S. CANAVAN

35. Keyword Text
RATIONS
THERMOSTABILIZED
PROCESS
QUALITY
CONTROL
CIM ARCHITECTURE
MACHINE VISION
ROBOTICS
DUAL USE
FLEXIBILITY
INTEGRATION
DATA BASE
SHOP FLOOR
IMPLEMENTATION
TECHNOLOGY TRANSFER

36.1 Objective
TO PROVIDE SKILLED ASSISTANCE TO PRODUCERS OF RATIONS TO HELP THEM DETERMINE THE USEFULLNESS OF NEW OR DIFFERENT TECHNOLOGY, OR TO HELP THEM IMPLEMENT ADVANCED TECHNOLOGY IN THEIR OWN PLANTS. THE PRIMARY TASK OF THIS PROJECT IS TO STUDY THE MANUFACTURABILITY OF ENTREES IN POLYMERIC TRAYS FOR GROUP FEEDING.

37.1 Approach
THIS PROJECT IS ESTABLISHED TO PROVIDE ASSISTANCE ALMOST ON DEMAND FROM RATION PRODUCERS. IN THIS TIME PERIOD, A STUDY ON MANUFACTURABILITY OF ENTREES IN POLYMERIC TRAY PACK CONTAINERS WILL BE CONDUCTED, AND THE RESULTS WILL BE SHARED WITH ALL OF INDUSTRY.

38.1 Progress
THIS PROJECT HAS BEEN COMPLETED, AND THE FINAL REORT IS BEING SUBMITTED

30. Primary PE No.	31. 1st Contrib. PE No.	32. 2nd Contrib PE No.
0708011S		
30A. Primary Proj. No.	31A. 1st Contrib. Proj. No.	32A. 2nd Contrib. Proj. No.
96004		
30B. Primary Task No.	31B. 1st Contrib. Task No.	32B. 2nd Contrib. Task No.
STP 1002		

30. Primary Funding Data			31. 1st Cont. Funding Data			32. 2nd Cont. Funding Data			33. Contract Rollup Indicator
Fiscal Year	Dollars	Work Year	Fiscal Year	Dollars	Work Year	Fiscal Year	Dollars	Work Year	
C1	C2	C3	C1	C2	C3	C1	C2	C3	C
1999	6285	1							
D1	D2	D3	D1	D2	D3	D1	D2	D3	D
1998	5490	1							
E1	E2	E3	E1	E2	E3	E1	E2	E3	E
1997	11247	1							
F1	F2	F3	F1	F2	F3	F1	F2	F3	F
1996	16736	1							
G1	G2	G3	G1	G2	G3	G1	G2	G3	G

39A. Product Set No.	39.1A Prod. Title Class Code	39.2A Product Title	
	Unclassified		
39.3A Product ID/Report No		39.4A Product AD No	39.5A Product Indicator

39B. Product Set No.	39.1B Prod. Title Class Code	39.2B Product Title	
	Unclassified		
39.3B Product ID/Report No		39.4B Product AD No	39.5B Product Indicator

39C. Product Set No.	39.1C Prod. Title Class Code	39.2C Product Title	
	Unclassified		
39.3C Product ID/Report No		39.4C Product AD No	39.5C Product Indicator

39D. Product Set No.	39.1D Prod. Title Class Code	39.2D Product Title	
	Unclassified		
39.3D Product ID/Report No		39.4D Product AD No	39.5D Product Indicator

39E. Product Set No.	39.1E Prod. Title Class Code	39.2E Product Title	
	Unclassified		
39.3E Product ID/Report No		39.4E Product AD No	39.5E Product Indicator

34. Contract/Grant/Trans. No.	34.1 Contract Effective Date	
34.2 Contract Expiration Date	34.3 Contract Face Value	34.4 Contract Cum. to Date
SPO10396D0016/05	1996/11/06	
1999/08/31	397577	376310

40. Dom. Tech Trans.	
41. Study Category	
42. Spec. Study Sub	
44. Prim. Proj. Serial No	
45. Int. Sources Con.	
46. Processing Date	
47. Receipt Date	

49. Thrust Indicator

Technology for Affordability

Focal Point
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Author
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Status Code